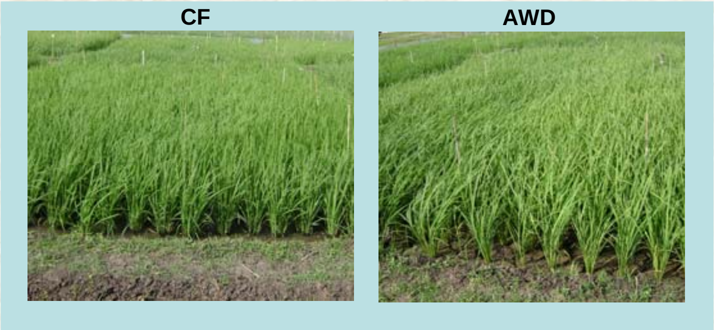
Water productivity and grain yield in irrigated rice fields as affected by alternate wetting and drying conducted in distinct soil types in the Philippines

Introduction

Rice consumes 2000 L of water on the average (ranging from 800 to 5000 L) to produce 1 kg grain (Bouman et al. 2007). The growing water shortage had prompted IRRI scientists to search ways to reduce water input in irrigated rice. The alternate wetting and drying (AWD) technique has been developed, and has a tremendous potential to produce rice using less water. It is now being promoted in farmers' fields, but without any recommendations with regards to soil types which can be quite variable in irrigated rice systems. This study aimed to compare the effect of soil types on water input, water productivity and grain yield between AWD and continuous flooding using two rice genotypes.



Materials and methods

- Field experiments of different soil types in farmers' fields were conducted in Tarlac, Philippines during the 2008 dry season.
- Two contrasting genotypes, H5 (high-yielding hybrid) and I4 (popular in farmer's field and promising inbred under AWD) were grown under both AWD 30 (irrigation whenever soil water potential was -30 kPa at 15 cm soil depth) and continuous flooding (CF) in 5 different soil types (Table 1).
- Jetfill tensiometers were installed in the plots to guide irrigation timing and water guage valve was installed to quantify the volume of water applied per plot (Fig 1).
- Water input is the sum of the applied irrigation and rainfall for the whole crop. Water productivity was computed as the ratio of grain yield to the total water input.

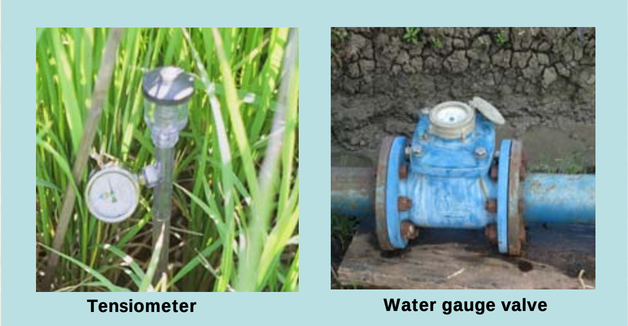


Figure 1.

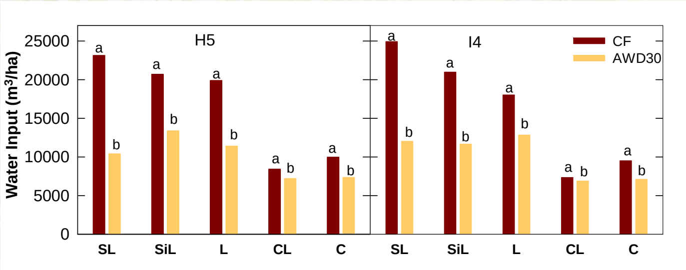


Fig. 2. Grain yield of H5 and I4 under AWD and CF grown in different soil types. Bars with same letter within each soil type are not significantly different at the 5% level using least significant difference (LSD).

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Results

- The result of particle size analyses, soil pH, organic carbon and cation exchange capacity is presented in Table 1. Percent clay ranges from10 to 63%. CEC and OC were highest in clay and lowest in sandy loam soil.
- The amount of water input (WI) was significantly lower in the AWD plots in all the soil types and in both H5 and I4. However, WI was lower in clay soils compared to the coarser soil types. Water input in clay soils were from 6,895 to 7,208 m3/ha in AWD while from 7,344 to 9,972 m3/ha in CF. Whereas in coarser soil types, WI were from 10,399 to 13,388 m3/ha in AWD plots while from 18,017 to 24925 m3/ha in CF (Fig 2).
- Water savings under AWD was 6-26% in clay soils while 29-55% in coarse soils.
- Water productivity (WP) increased significantly only in clay loam and clay soils in both H5 and I4. WP did not increased in the other soil types (Fig 3).
- Grain yield was significantly reduced in sandy loam, silty loam and loam soil by 47, 57, and 37% in H5 and by 25, 43, and 45% in I4, respectively. Grain yield, however, was maintained in clay loam and clay soils in both H5 and I4 (Fig 4).

Table 1. Soil physical and chemical properties in the experimental sites.
Organic carbon (OC), Cation exchange capacity (CEC)

Soil type	Chemical properties			Physical properties		
	Soil pH	OC (%)	CEC (meq/100 mg)	Clay (%)	Silt (%)	Sand (%)
Sandy Loam (SL)	6.6	0.34	6.24	10	20	70
Silt Loam (SiL)	7.2	0.66	16.45	18	55	27
Loam (L)	6.6	0.74	7.49	13	48	39
Clay Loam (CL)	7.6	1.31	24.80	34	42	24
Clay (L)	7.2	1.81	42.10	63	34	3

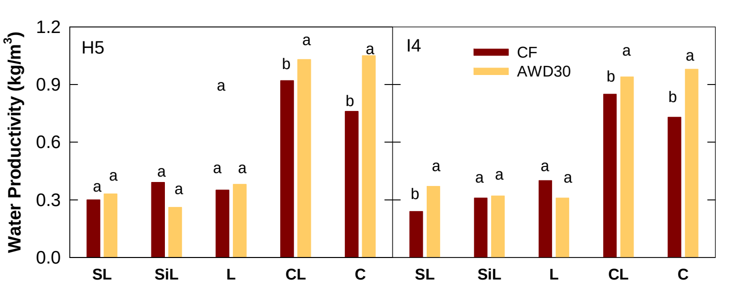

Fig. 4. Water productivity of H5 and I4 under AWD and CF grown in different soil types. Bars with same letter within each soil type are not significantly different at the 5% level using least significant difference (LSD).

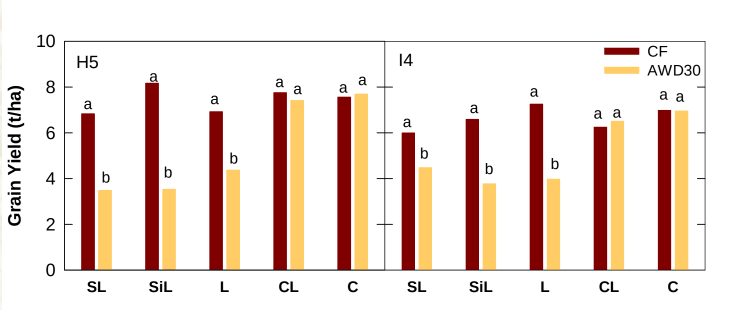

Fig. 4. Grain yield of H5 and I4 under AWD and CF grown in different soil types. Bars with same letter within each soil type are not significantly different at the 5% level using least significant difference (LSD).

Conclusion

- AWD technique at 30 kPa threshold confirmed here to be a relevant water saving management only in fine textured soils (clay soils) as indicated by the significantly lower amount of water input and higher water productivity while the grain yield was maintained as observed in both rice genotypes.
- AWD in sandy soils might require a lower threshold limit. The 30 kPa threshold for coarser soil types appeared here to be very strong since the grain yield was severely penalized. The implementation of AWD30 in farmer's field is not advisable under coarse or light soils.
- Grain yields of both H5 and I4 were significantly lower in the AWD in sandy soils but were maintained in clay soils.